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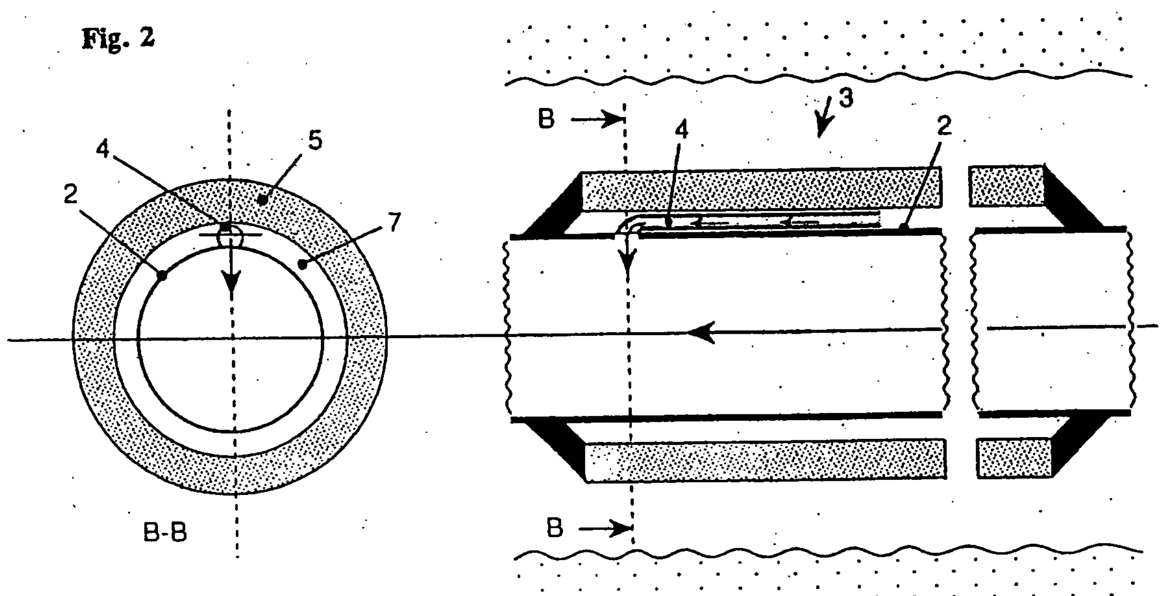
(71) Applicant: NORSK HYDRO TECHNOLOGY B.V.
P.O. Box 2
NL-4540 AA Sluiskil(NL)

(72) Inventor: Brekke, Kristian
Ullern alle 51
N-0381 Oslo(NO)
Inventor: Sargeant, Jon Petter
Lesterudveien 22
N-1350 Lommedalen(NO)

(54) **Method and production pipe in an oil or gas reservoir.**

(57) Method and production pipe for production of oil or gas from a well in an oil and/or gas reservoir, or injection of fluids into a well in an oil and/or gas reservoir, comprising a production pipe (1) with a lower drainage pipe (2).
The drainage pipe (2) is divided into sections (3) with one or more inflow-restriction devices (4) which control the flow of oil or gas from the reservoir into the drainage pipe on the basis of calculated loss of friction pressure along the drainage pipe, the reservoir's calculated productivity profile, and the calculated inflow of gas or water.

Fig. 2



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The present invention concerns a method for producing oil or gas from a well in an oil or gas reservoir, or of injecting fluids into a well in an oil or gas reservoir. The invention further includes a production pipe with a lower drainage pipe. The invention is particularly suitable for long, horizontal wells in thin oil zones in highly permeable geological formations. Devices for recovery of oil and gas from long, horizontal and vertical wells are known from US patent printouts nos. 4,821,801, 4,858,691, 4,577,691 and GB patent printout no. 2169018. These known devices comprise a perforated drainage pipe with, for example, a filter for control of sand round the pipe. A considerable disadvantage of the known devices for oil and/or gas production in highly permeable geological formations is that the pressure in the drainage pipe increases exponentially in the upstream direction as a result of the flow friction in the pipe. Because the differential pressure between the reservoir and the drainage pipe will decrease upstream as a result, the quantity of oil and/or gas flowing from the reservoir into the drainage pipe will decrease correspondingly. The total oil and/or gas produced by this means will therefore be low. With thin oil zones and highly permeable geological formations, there is a high risk of coning, i.e. flow of unwanted water or gas into the drainage pipe downstream, where the velocity of the oil flow from the reservoir to the pipe is greatest. To avoid this coning, the production rate must therefore be further reduced.

A somewhat higher production rate than that obtained by means of the known methods mentioned above can be achieved using the Stinger method, which is described in Norwegian patent application no. 902544. It consists of two drainage pipes: an outer, perforated one, and an inner pipe (Stinger) without perforation which extends into the outer pipe to the desired position. The pressure profile and thus productivity achieved by means of the Stinger method are somewhat better than those achieved by other known methods. In thin oil zones with a high permeability, however, coning of unwanted water or gas may occur with this method too, resulting in reduced productivity.

The technology for drilling horizontal wells was known in 1920 already, but there are nevertheless many people today who regard it as pioneering technology. For the past twenty years work has been continuously in progress to develop means of drilling horizontal wells in a prudent, effective manner. The current state of technology offers high drilling safety and costs approximately 50% higher than for vertical wells. However, horizontal wells produce three to four times as much, depending on the nature of the reservoir.

It has been proved that horizontal wells are an economic necessity for recovering oil from geological formations with a thin oil zone, high permeability and in which coning of unwanted water or gas often occurs. It is anticipated that horizontal wells will be even more important in the future for exploiting small and economically marginal oil and gas fields.

As well-drilling technology developed, the requirements made of reservoir drainage technology were also intensified. As described above, the known drainage technology of today has no satisfactory solutions for controlled drainage from and injection into different zones along the horizontal well.

The purpose of the present invention is to improve the pressure profile in the drainage pipe beyond what is known from the solutions mentioned above, by introducing restrictions which limit the pressure differencial between the reservoir and the annular space outside the drainage pipe, and thereby straighten out the pressure profile along the well immediately outside the drainage pipe.

According to the invention this is achieved by a method as mentioned initially and which is further characterised in that the drainage pipe is divided into sections with one or more inflow-restriction devices which control the flow of oil or gas from the reservoir into the drainage pipe on the basis of anticipated loss of friction pressure along the drainage pipe, the reservoir's anticipated productivity profile and anticipated inflow of gas or water as defined in Claim 1.

The invention further includes a production pipe for production of oil or gas from a well in an oil and/or gas reservoir, characterised by a lower drainage pipe divided into a number of sections with one or more inflow-restriction devices as defined in Claim 2.

Particularly advantageous features of the invention are defined in the dependent Claims 3-4.

The invention will now be described in more detail, with reference to an example and appended drawings in which:

Fig. 1 shows a vertical section through a horizontal well in which a production pipe has been placed according to the invention.

Fig. 2 shows in a larger scale a section through the drainage pipe as shown in Fig. 1, with filter, inflow-restriction devices and annular space for inflow of fluid.

Fig. 3 shows in a larger scale a section through the drainage pipe as shown in Fig. 1, with an alternative inflow-restriction device. Fig. 4 shows by means of a mathematically simulated example, the pressure profile along the drainage pipe as obtained by means of the invention, compared

with known solutions.

As mentioned above, Fig. 1 shows schematically a vertical section through a drainage pipe according to the invention for a horizontal production well (not shown in more detail) for recovery of oil or gas in an oil and/or gas reservoir. The lower part of the production pipe 1 is a horizontal drainage pipe 2 consisting of one or more sections 3 along the whole length of the pipe, and one or more inflow-restriction devices 4, a filter 5 when the geological production formation requires it, and a sealing device 6 between the sections 3, which forms a seal between the drainage pipe 2 and the geological well formation.

Figs 2 and 3 show two examples of inflow-restriction devices 4 for the drainage pipe 2. The function of the inflow-restriction devices is to prevent uncontrolled flow from the reservoir into the drainage pipe by evening out the loss of friction pressure immediately outside and along the whole length of the drainage pipe. The inflow-restriction devices are the only connection between the reservoir and the drainage pipe.

Fig. 2 shows a section through the drainage pipe as shown in Fig. 1. Fluid flows through the permeable geological formation to the sand-control filter 5 and through this to an annular space 7, and then, as a result of the differential pressure between the reservoir and the drainage pipe, flows towards and through the inflow-restriction device, as shown in section B-B, and in to the drainage pipe.

Fig. 3 shows a section through a drainage pipe with an alternative inflow-restriction device 4. In this example the inflow-restriction device 4 consists of a thickening in the form of a sleeve or gate 9 equipped with one or more inflow channels 8 which permit inflow to be regulated by means of one or more screw or plug devices 10 and 11. The screw device 10 shows a situation in which an inflow-channel is closed and device 11 shows a situation in which the inflow channel is open. In this manner, by using short or long screws which extend into the channels as shown here, the length of the through-flow sections of the channels, and thereby the flow of oil to the drainage pipe for each section can be varied. However, instead of using short and long screws, and keeping the channels open or closed, it is possible instead to use medium-sized screws or pin-regulating devices which extend partially into the channels and which are designed to regulate the through-flow cross-section of the channels. It is advisable to preset the screws before the drainage pipe is placed in the well, but driven pin-regulating or screw devices with remote control can also be used.

Throughgoing slots or holes in the drainage pipe with a surrounding sleeve which is adjustable in the longitudinal direction for each section can also be used.

Fig. 4 shows three curves which are a comparison between the pressure profile of the invention and the pressure profiles of known solutions. The curves show the results of mathematical model simulations. On the y axis, well and production pipe pressure is given in bars, and on the x-axis the length of the production pipe is given in metres.

The figure shows pressure curves A and B for known solutions, and curve C for the invention. The reservoir pressure is shown as a straight line at the top. The most favourable for productivity is to achieve a pressure curve along a homogeneous formation which is even and nearly horizontal with an evenly distributed flow into the drainage pipe. An evening out of the loss of friction pressure along the entire length of the drainage pipe is thereby achieved.

In pressure curve C, representing the invention, this is achieved, but not in pressure curves A and B, which are the known solutions.

Curve A indicates how the pressure profile rises with the length of the drainage pipe in the upstream direction for continuously perforated production piping with an internal diameter of about 15 cm.

Curve B, the Stinger method, has a pressure profile which is lower on average than curve A, but has the same form as far as the Stinger tube's entry, and then rises.

The overall effect, then, is that curve B gives a somewhat higher productivity over the whole length of the drainage pipe than curve A.

Curve C, which represents the invention, gives a steady, horizontal and low pressure profile over the entire length of the drainage pipe, and is the most beneficial solution, and the one which will result in the highest productivity.

Claims

1. Method for production of oil or gas from a well in an oil and/or gas reservoir, or injection of fluids into a well in an oil and/or gas reservoir, involving a production pipe (1) with a lower drainage pipe (2),
   characterised in that the drainage pipe (2) is divided into sections (3) with one or more inflow-restriction devices (4) which control the flow of oil or gas from the reservoir into the drainage pipe on the basis of calculated loss of friction pressure along the drainage pipe, the reservoir's calculated productivity profile, and the calculated inflow of gas or water.

2. Production pipe (1) for production of oil or gas from a well in an oil and/or gas reservoir,

characterised in that a lower drainage pipe (2) is divided into a number of sections (3) with one or more inflow-restriction devices (4).

3. Drainage pipe according to claim 2, **characterised in that** the inflow-restriction devices (4) are arranged such that their inlets are in contact with the geological production formation, or an annular space between a filter (5) and the drainage pipe and an outlet is in contact with the flow space of the drainage pipe.

4. Drainage pipe according to claim 3, **characterised in that** the inflow-restriction devices (4) consist of one or more inflow channels (8).

5. Drainage pipe according to claim 4, **characterised in that** the inflow channels (8) are located in a thickened section of the drainage pipe (2) in the form, for example, of an external or internally fitted sleeve (9).

6. Drainage pipe according to claims 4 or 5, **characterised in that** the length, cross section and number of the inflow channels (8) can be varied by means of plugs, in the form of screws (10, 11) for example.

7. Drainage pipe according to claim 3, **characterised in that** the inflow-restriction devices (4) consist of one or more throughgoing slots in the drainage pipe (2) which may be of varying length and breadth.

8. Drainage pipe according to claim 7, **characterised in that** the length and number of the slots can be varied by means of displaceable sleeves or gates installed outside or inside.

9. Drainage pipe according to claims 3, 6 and 7, **characterised in that** the flow-control feature of the inflow channels (8) is driven and can be adjusted by means of remote control and is designed to allow the quantity of oil flowing through during production to be increased or decreased.

10. Drainage pipe according to claim 2, **characterised in that** the inflow-restriction devices (4) are equipped with, for example, a nipple in the drainage pipe (2) for fitting a repairs tool, or a shut-off or stimulation device.

11. Drainage pipe according to claim 2, **characterised in that** between the drainage pipe sections (3) there is a sealing device (6) between the drainage pipe (2) and the geological formation.

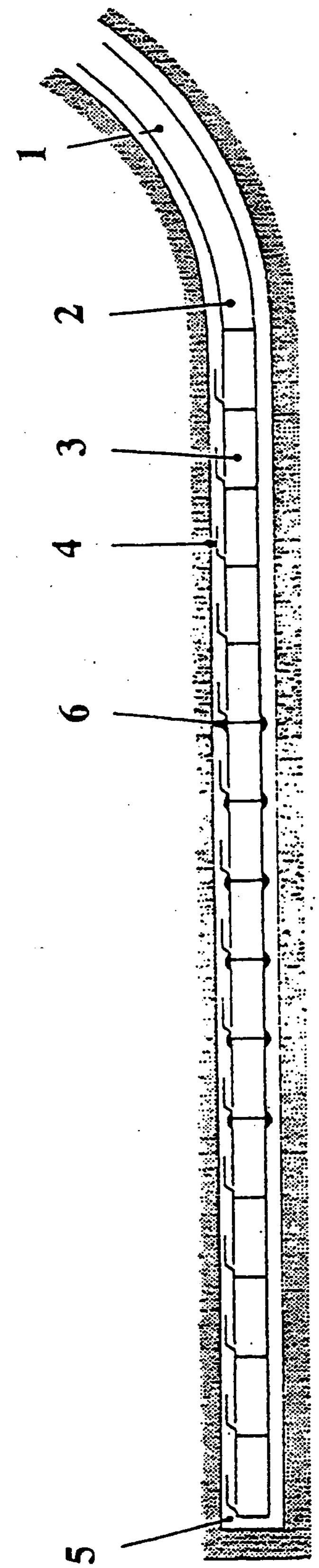
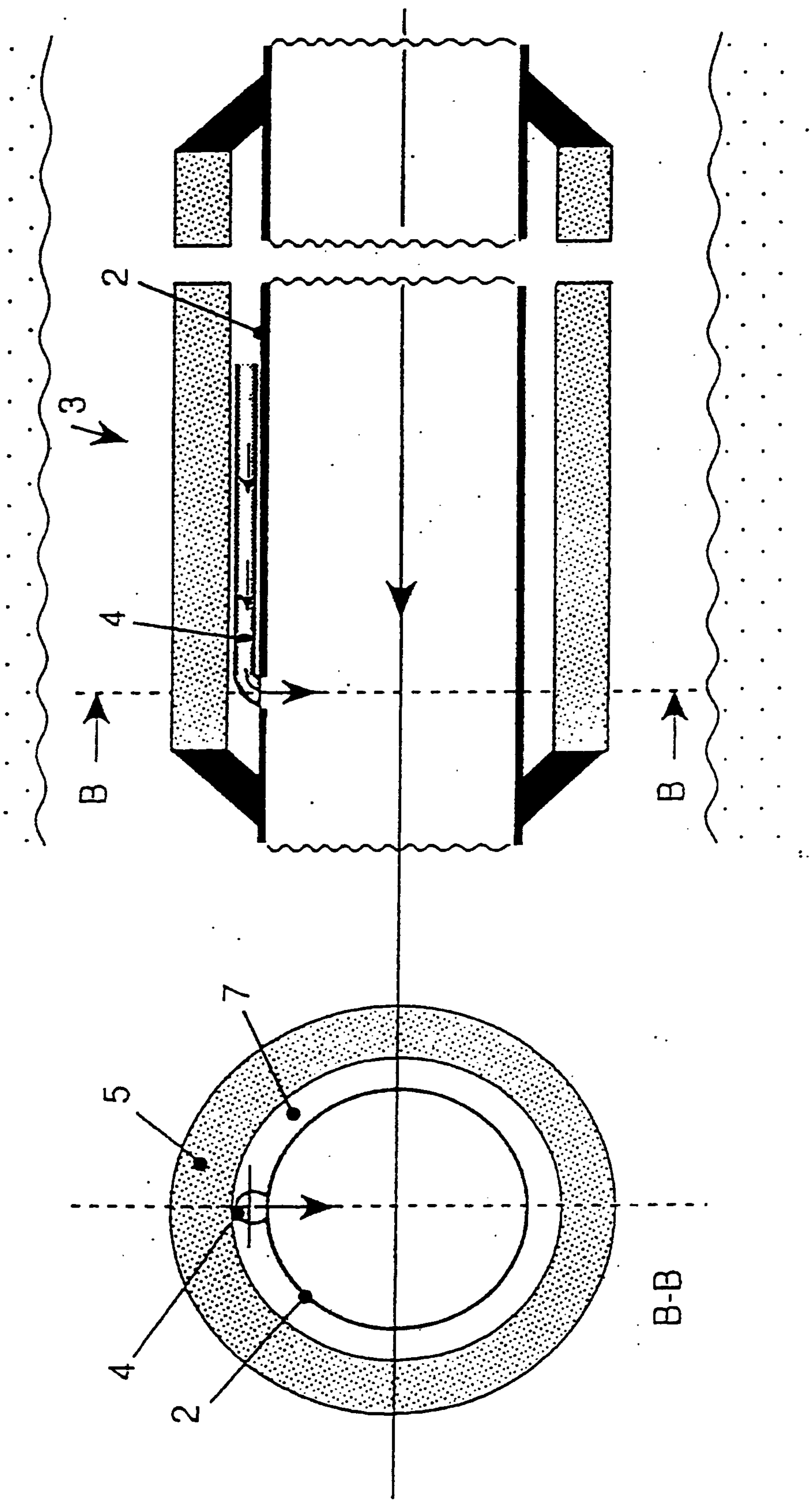


Fig. 1

Fig. 2



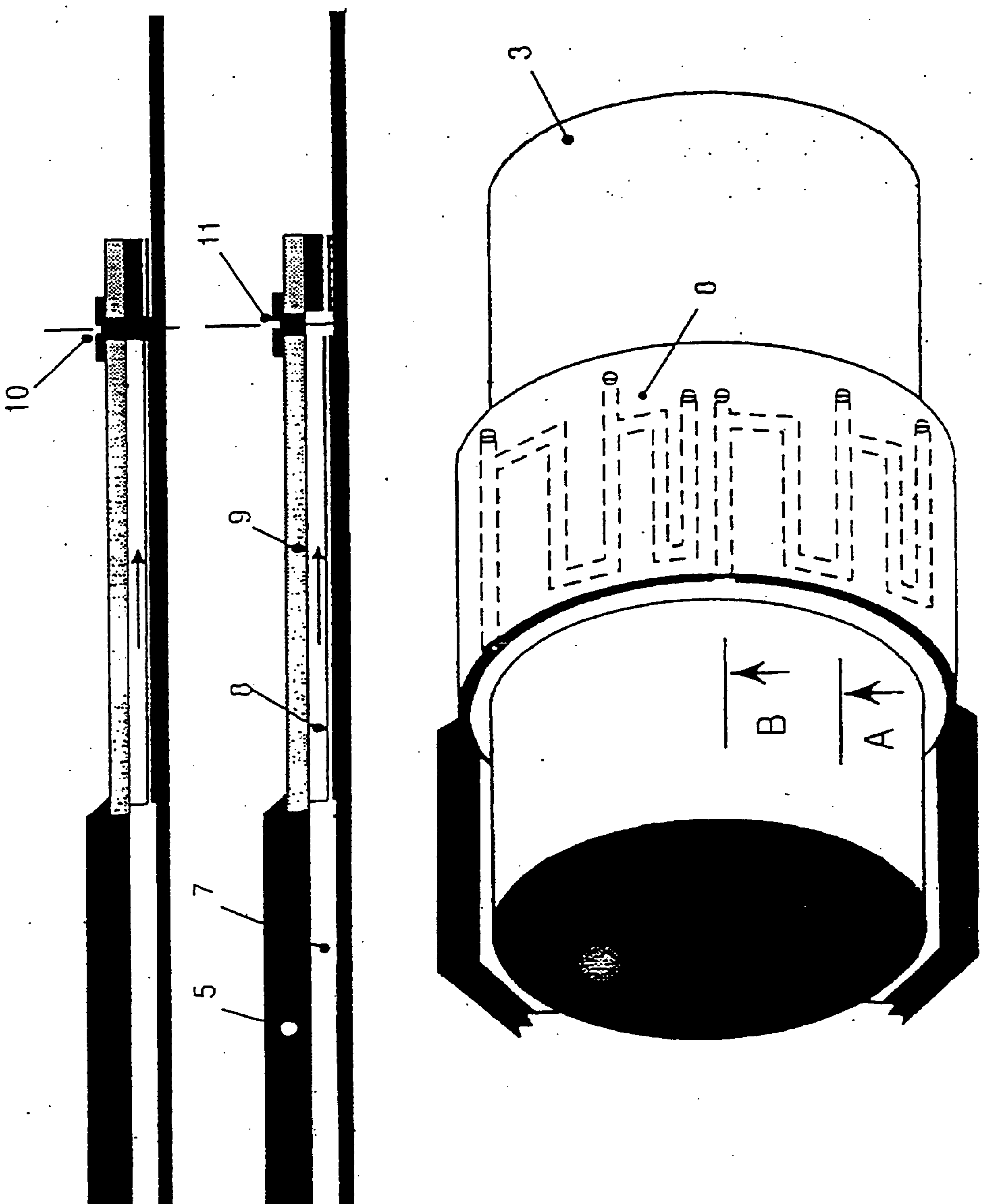


Fig. 3

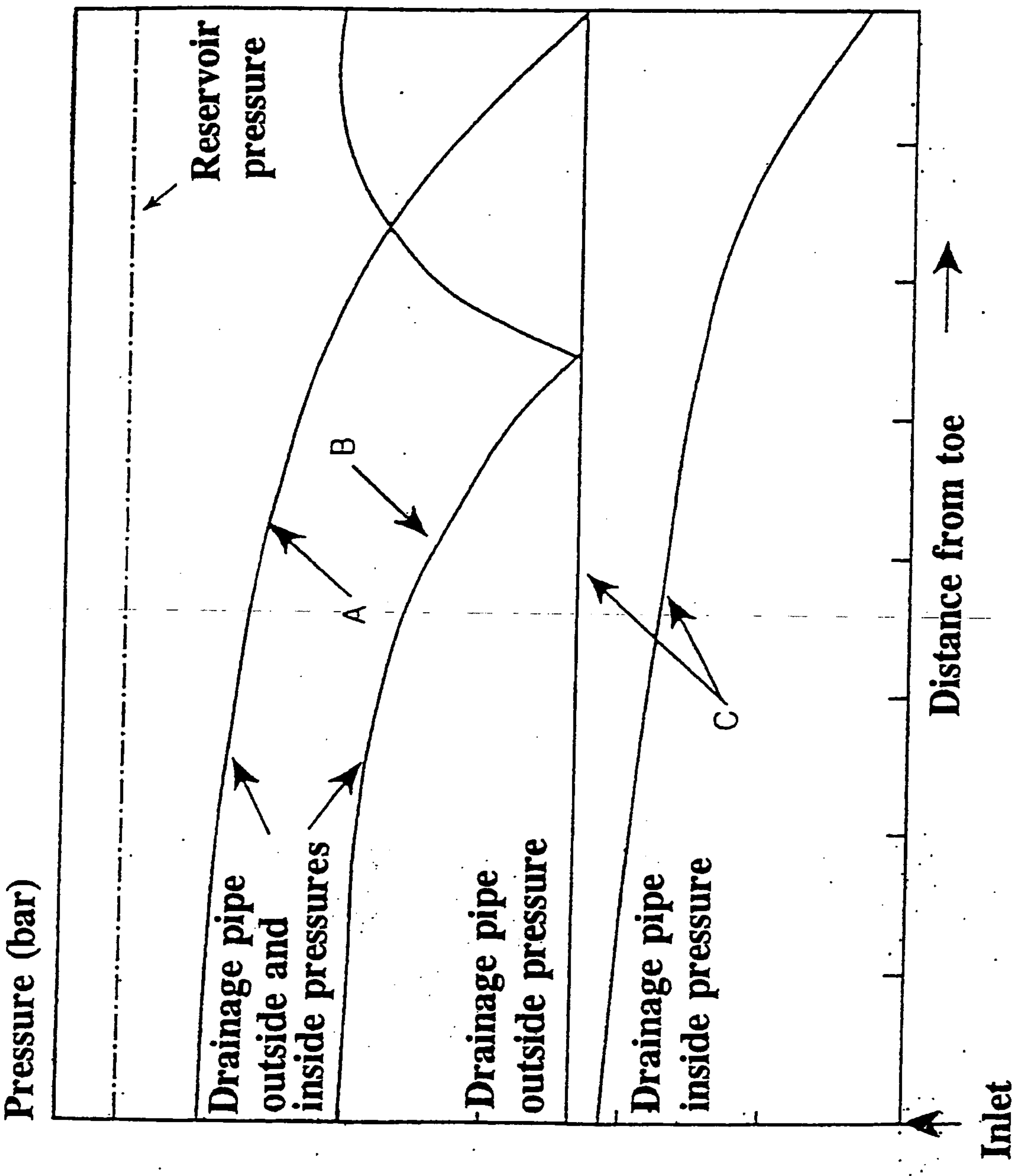

Pressure (bar)
Reservoir pressure
Drainage pipe outside and inside pressures
Drainage pipe outside pressure
Drainage pipe inside pressure
A
B
C
Inlet
Distance from toe

Fig. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 20 2624

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	WO-A-92 08875 (FRAMO)	2-4,6, 9-11	E21B47/12 E21B17/18
A	* the whole document *	1,5,7,8	
X	WORLD OIL vol. 212, no. 11 , November 1991 , HOUSTON-TEXAS pages 73 - 80 C. WHITE & M. HOPMANN 'controlling flow in horizontal wells'	2,3,7,8, 10	
A	* the whole document *	1	
A	GB-A-2 196 410 (WOOD) * figure 1 *	2-4	
A	FR-A-2 407 337 (MARAIS) * page 4, line 23 - line 30; figures 1-4 *	2	

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

E21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 December 1993	Fonseca Fernandez,H

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

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E : earlier patent document, but published on, or after the filing date
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